NAVAJO LAKE

DRAFT Total Maximum Daily Load and Water Quality Management Plan

Prepared by

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Utah Department of Water Quality, Division of Water Quality
TMDL Section

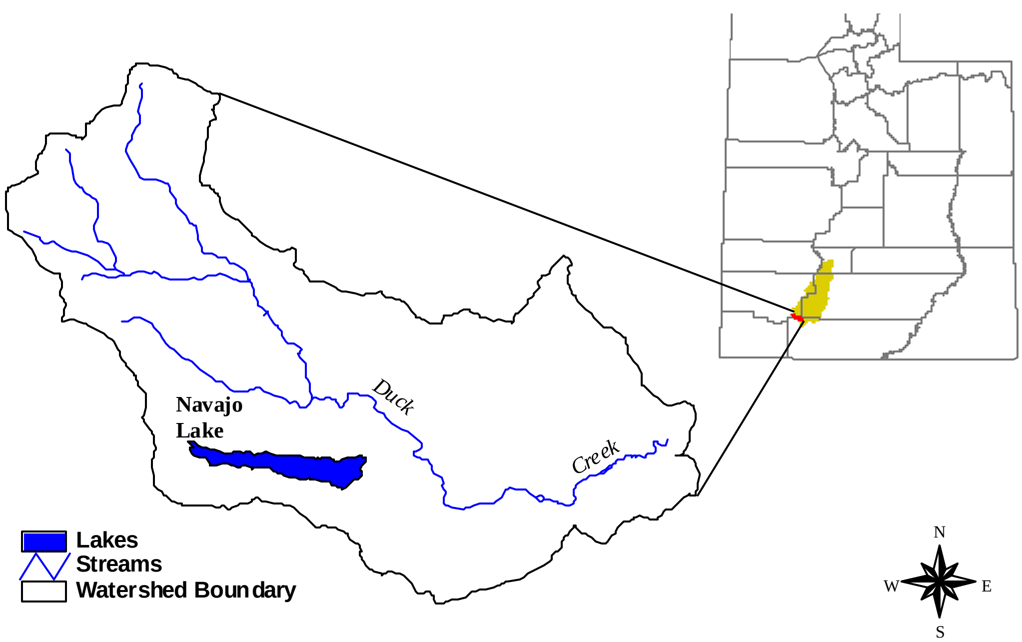
Waterbody ID	Navajo Lake
Location	Garfield County; South-Central Utah
Pollutants of Concern	Dissolved Oxygen
Impaired Beneficial Uses	Class 3A: Cold water fishery
Loading Assessment	Not Applicable
Defined Targets/Endpoints	No endpoints identified. Recommended for de-listing due to natural conditions.
Implementation Strategy	No implementation strategy.
This document is identified as a TMDL for the Upper Sevier River and is officially submitted under §303d of the CWA for EPA approval.	

I. INTRODUCTION

Waterbody Description

Navajo Lake is a small lake located in southwestern Utah on the Markagunt Plateau in the northwest comer of Kane County, about 40 kilometers (25 mi) east of Cedar City, Utah (Map 1). The lake formed when a lava flow cut off the uppermost part of the natural surface drainage of Duck Creek, a headwater tributary of the Sevier River. Navajo Lake has a maximum surface area of 290 hectares (714 ac) and an average depth of 3.7 meters (12.1 ft), and is at an altitude of 2754 meters (9035 ft). The topographic basin containing Navajo Lake is about 1600 hectares (4000 ac). The lake is primarily used for recreational purposes, although outflow from the lake contributes to flows in both the Sevier River in the Great Basin drainage and the Virgin River in the Colorado River drainage. The lake's alpine setting makes the area a highly-valued summer recreation area. The lake is entirely surrounded by the Dixie National Forest with some private in-holdings developed with summer homes. Facilities near the lake include three Forest Service Campgrounds, a privately owned lodge and boat ramp, and 34 private summer homes along the southwest side of the lake.

Map 1. Navajo Lake Watershed and Major Streams



The main water problems in the lake are fairly heavy vascular water plant (macrophyte) growth, which clogs much of the lake by late summer during some years, and low dissolved oxygen during winter months from the decay of macrophytes under the ice. This situation is worsened by the shallowness of the lake which limits fish habitat and is exacerbated by low water years. Although the lake is oligotrophic and nutrient sources are minimal, the primary impairment is the potential for fish mortality during conditions of low dissolved oxygen.

This document represents the findings of an EPA Clean Lakes Study (1996) submitted by the Division of Water Quality which fully assessed the conditions of the lake and determined nutrient sources and loadings from the watershed. The conclusions of the study found that nutrients sources in the watershed and in the lake were minimal and recommended options in-lake treatments for fishery maintenance.

Surface and Groundwater hydrology

Navajo Lake was created several thousand years ago after a lava flow cut off the natural surface flow of the uppermost part of Duck Creek in the Sevier River Drainage. The lake is unique in that groundwater accounts for most of the inflow and all of the outflow. Sinks located on the east end of the lake are the principal outlets; no surface outflow exists for the lake. Sinkholes in the east end of the lake drained the lake completely in low water years before construction of a north-south dike, just west of major sinkholes on the east end of the lake basin (see Photo 1).

Photo 1. View of Navajo Lake and dike.

The dike has been raised in stages beginning in about 1933. It was last raised to 5.2 m (17 ft) in 1945. The dike allows the lake to be maintained near 4 to 5 m (13-16 ft) deep; however evaporation and seepage, and release of irrigation water via a pipe outlet, still drop the water level a few feet below the dike spillway level by late summer in most years.

Subterranean flow from a considerably large area to the north contributes flow into the lake via seepage, solution channels in limestone, and perhaps tubes and fractures in basalt layers. A large portion of the annual inflow enters during spring snowmelt and runoff. Several springs along the north shore are solution-channel springs which appear to be connected to sinkholes in basins immediately to the north, which flow mainly during snowmelt or heavy storm runoff and add large quantities of water during wet years. These springs and seeps dry up rapidly after the peak of spring runoff. Navajo Lake Spring on the west end, and Elderberry Spring and Larson Spring on the southwest side of the lake are the only perennial springs feeding the lake. By late summer in a normal year, flowrates are less than 0.1 cfs in Elderberry and Larson Springs and less than 1 cfs in Navajo Lake Spring.

The entire subsurface area of Navajo Lake is interlaced with limestone solution cavities and solution channels and lava tubes. Water flows not only out of the east end sink holes but likely feed small seeps and springs located west of Cascade Spring on the steep face at the head of the Virgin River basin. The outlet of the lake is via sinkholes east of the dike and other seepage from the lake bottom; there is no surface outflow from the lake basin. The flow into the Navajo Lake sinks reappears in Cascade Spring to the south and Duck Creek Spring to the east. The percentage of flow is approximately 60% to Duck Creek Spring and 40% to Cascade Spring. The amount of flow into the sinks is dependent on the water's elevation head above the sinks. The flow is approximately 30 cfs when the elevation of the water above the sinks is 9 m (30 ft) (about the maximum lake depth in historical times). The basin drainage into the lake, as alluded to before, consists of subsurface travel from areas lying outside of the basins topographical boundaries. Since inflow and outflow of Navajo Lake basin is mostly subterranean, a normal water budget is not possible. During maximum spring runoff in 1993, it is estimated that approximately 80 cfs was coming into the lake. Of this, only about 25% was in measurable surface inflow.

Statement of Intent

This TMDL addresses the water quality impairment of Navajo Lake for submittal to the United States Environmental Protection Agency. The goal of the TMDL is to meet water quality standards associated with the waterbody’s designated beneficial uses.

II. Water Quality Standards

This document addresses water quality impairments for Navajo Lake through the establishment of Total Maximum Daily Loads (TMDL) for pollutants and sources of concern. Navajo Lake been listed on the 2002 303(d) list of impaired waters. The State of Utah has designated Navajo Lake as coldwater (3A) fisheries and impairment of this designated uses exist due to low dissolved oxygen. The primary cause of the low dissolved oxygen is a combination of morphological conditions and excessive growth of macrophytes which decay under the winter ice and results in oxygen depletion.

Impaired Waters

Utah's Year 2002 303(d) list identifies Navajo Lake as being impaired due to water quality numeric exceedences of the minimum dissolved oxygen criteria for the support of a coldwater fishery (see Table 1).

Table 1. Impaired Waterbodies and pollutants of concern.

Waterbody	Waterbody ID	Impaired Designated Use	Cause of Impairment
Navajo Lake	**UT16030001-005**	**3A**	**Low Dissolved Oxygen**

The listing is based on the findings of the Phase I EPA Clean Lakes Study (1993). The beneficial uses, as designated by the State of Utah (DWQ, 2000b), for Navajo Lake are:

- 2B – Protected for secondary contact recreation such as boating, wading, or similar uses;
- 3C – Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain;
- 3D – Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain
- 4 – Protected for agricultural uses including irrigation of crops and stock watering

II. Water Quality Standards and Impairments

Utah water quality standards (UAC R317-2,) and the 303(d) listing criteria (UDEQ - DWQ, 2002) provide the criteria to make an initial assessment of water quality conditions. The Utah water quality standards establish a narrative criteria for coldwater fishery (Class 3A) waters (Table 6.). While additional designated uses exist for Navajo Lake, 3A classification carries the strictest criteria for the pollutants of concern (POCs).

Table 2. Utah Water Quality Criteria for Class 3A Waters

Parameter	Criterion Minimum Concentration
Dissolved Oxygen -Lakes	4.0 mg/l (in 50% of water column)

DWQ lists any waterbody assessed as ‘partially supporting’ or ‘not supporting’ its beneficial uses on the 303(d) list with the exception of those waterbodies for which a TMDL study has already been completed and approved by the EPA. According to DWQ's assessment Navajo Lake is not meeting beneficial uses associated with coldwater fishery (3A) . The 303(d) listing criteria provide guidance on evaluating beneficial use support status based on the number of violations of the water quality criterion as listed in Table 3.

Table 3. 303 (d) Criteria for Assessing Beneficial Use Support

Degree of Use Support	Conventional Parameter
Non-Support (3A Lakes)	Any lake profile with >50% of water column below the 4.0 mg/l DO criterion.

While some historic dissolved oxygen data exist for Navajo Lake, most sampling has occurred during the summer months when the lake is well mixed and exhibits high DO values. However, according to the Utah Divison of Wildlife Resources, some degree of fish mortality occurs each year during the winter months as the shallow lake ices over and macrophyte decay depletes the dissolved oxygen (Hepworth, 2003). Management of the fishery has included the piping of spring water into the lake to increase dissolved oxygen levels and create a refuge for trout to over-winter. However, measurements of dissolved oxygen near the spring outfall which range between 4-6 mg/l drop rapidly within a 50 foot radius of the spring to below 1 mg/l. Trout survival is highest during years when spring flow is high and more oxygen rich water is entering the lake and when Utah chub population (and thus competition with trout for refuges) is low. Rotenone treatment of the chub population has resulted in higher trout survival over the winter months (Hepworth, 2003).

III. Pollution Assessment

Human Sources

The Navajo Lake watershed is 100% Forest Service Land with some private in-holdings utilized for summer home development. General recreation use and grazing are potential, but are limited sources of nonpoint nutrient pollution. The campgrounds and summer homes around the Lake are on total containment systems for waste removal. The Navajo Lodge, however, has a septic system with leach fields which are submerged during unusually high lake levels.

Point Sources

Currently, no point sources exist within the Navajo Lake watershed.

IV. Linkage Analysis

The main problem experienced at Navajo Lake is oxygen depletion under winter ice. This problem stems largely from decomposition of macrophytes and algae; macrophytes grow rather profusely during most summers. The dissolved oxygen depletion under winter ice is not a recent problem in Navajo Lake; it dates back to initial formation behind the dike over 60 years ago (DWQ, 1996).

V. Water Quality Analysis

As mentioned earlier, there are very few measurable sources of inflow to the lake. The few surface tributaries were monitored when significant flow existed. The outflow is entirely seepage and subterranean flow, largely through the natural sinks in the east end of the lake. Cascade and Duck Creek Springs were sampled to add more information to the USGS studies showing these as major outflow recipients via Navajo Lake sinks. Major springs were also sampled to determine the water quality of inflows to the lake. The include the following STORET sites:

Cascade Spring (495125) – Located over the ridge approximately 2 km (1.2 mi) south of the Navajo Lake Sinks. The flow in Cascade Spring is largely from the Navajo Lake Sinks.

Duck Creek Spring (594675). Located adjacent to Highway 14,4.8 kin (3 mi) east of Navajo Lake. Part of this flow originates from the Navajo Lake Sinks.

Boy Scout Spring (594689). Located on the west end of Navajo Lake. Only one flow measurement, 0.5 cfs, was recorded during the study period in June 1993. Flow was less than 0.1 cfs after that time and not sampled.

Navajo Lake Spring (594691). Spring just to west of Navajo Lake. Pipeline captures most of the flow after inlet renovation in 1994. It was submerged during most of 1993 by the high lake level.

Larson Spring (594695). Located on east side of Navajo Lake Lodge. Provides potable water to the lodge and rental cabins. Continuous flow year- round, but less than 0.2 cfs except during the spring and early summer when it flows up to 1 cfs.

There are other sources of inflow to the lake which, in general, cannot be sampled. These consist of underlake springs and springs adjacent to the lake which flow only during heavy snow melt. Four of these springs deserve mention. First, Roaring Spring comes from a solution channel about 20 m (70 ft) up the hillside. It is located along the north shore approximately 0.5 km (0.75 mi) east of the lodge. Roaring Spring may flow up to 20 cfs or so during spring runoff. This spring drains a considerable portion of the watershed just above the lake as the flow is short-lived each spring. West of Roaring Spring is another similar solution channel spring which flowed about 2 cfs during the first two sampling trips in June. Another spring, Breathing Spring, is located about 0.9 km (1.5 mi) from the lodge along the north shore. Breathing Spring is submerged and appears to be an important source of oxygenated water under the winter ice. It has been observed that fish congregate around this spring to escape from the low oxygen conditions which sometimes occur in the lake during ice cover. The fourth spring is located near the dike on the north shore. It is also submerged and is reported to be foul- smelling and devoid of oxygen. A sulfide smell is sometimes detectable around this part of the lake. Both of the last two springs were submerged beneath 6 to 9 m (20 to 30 ft) of water during the sampling period and could not be identified nor sampled.

Table 4 gives the averages for samples collected from Cascade Spring and Duck Creek Spring. The 1964 USGS report identified Navajo Lake Sink outflow water as dividing about 40% to Cascade Spring and making up essentially all of the flow there, and 60% to Duck Creek Spring and making up half or less of the flow there.

Table 4. Water Quality in Cascade Spring, and Duck Creek (Averages for 1993)

Parameter	**Cascade Spring**	**Duck Creek**	**Lake Site #1**
Temperature (C)	10.58	8.37	13.8
Dissolved Oxygen (mg/l)	7.63	7.8	8.5
Field pH	8.0	7.74	8.4
Sp. Conductivity (umhos/cm)	235	249	212.3
Flow (cfs)	12.5	14.8	N/a
Total Alkalinity (mg/l)	136.6	122.2	108.3
Total Hardness (mg/l)	134.5	119.2	97.4
Nitrate + Nitrite (mg/l)	0.09	0.1	0.04
Total Kjeldahl Nitrogen (mg/l0	0.3	0.25	0.27
Total Nitrogen (mg/l)	0.39	0.35	0.31
Total Phosphorus (mg/l)	0.01	0.02	0.01
Dissolved Phosphorus (mg/l)	0.01	0.02	0.01

In general, water quality in the lake and in the outflows of the lake are good with Total Phosphorus (TP) and Total Nitrogen (TN) concentrations typical of a high quality oligotrophic lake. Since most of the inflows could not be measured or sampled accurate nutrient loadings to the lake can not be determined. However nutrient levels in two perennial springs, Navajo Lake and Larson Springs are probably indicative of the water quality of the inflows; generally TN was less than 0.22 mg/l and TP was less than 0.02 mg/l.

Lake data.

The Clean Lake Study summarizes the dissolved oxygen concentration for the years of 1993-4 and found that DO did not drop below 7 mg/l. The mean concentration was 8.5 mg/l for all three stations on the lake. These stations include “Above the Dam” (594681), “Mid-Lake” (594682), and the “Upper End” (594683). Data from the years 1997-2003 compare with data from the Clean Lakes study and are summarized in Table 5.

Table 5. Water quality for all three lake sites by year 1997-2003

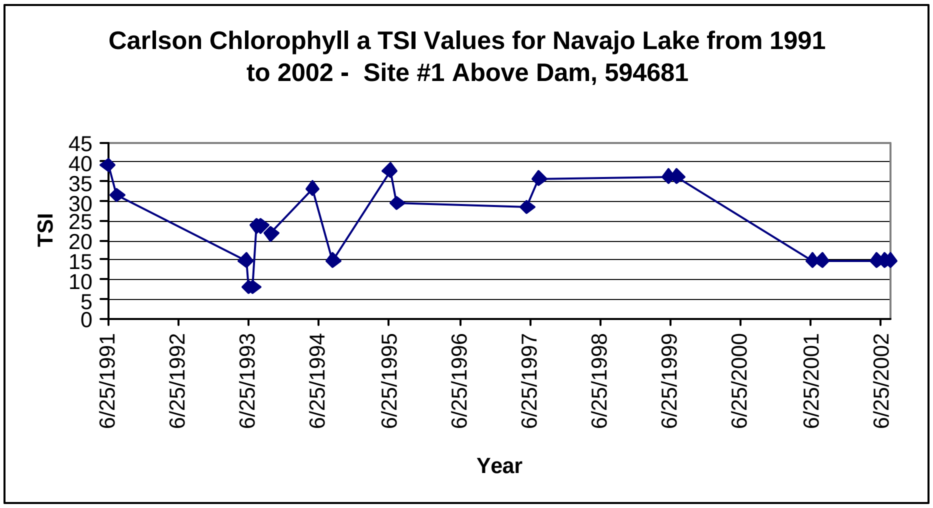
Year	Total Phosphorus			Dissolved Oxygen			Chlorophyll a		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1997	0.029	0.005	0.058	8.92	7.95	10.49	1.67	1.4	1.8
1999	0.01	0.01	0.01	9.63	8.7	11.4	2.42	1.8	3.6
2001	0.01	0.01	0.01	9.0	7.38	10.5	0.2	0.2	0.2
2003	0.012	0.01	0.029	8.7	6.46	9.9	0.3	0.2	0.5

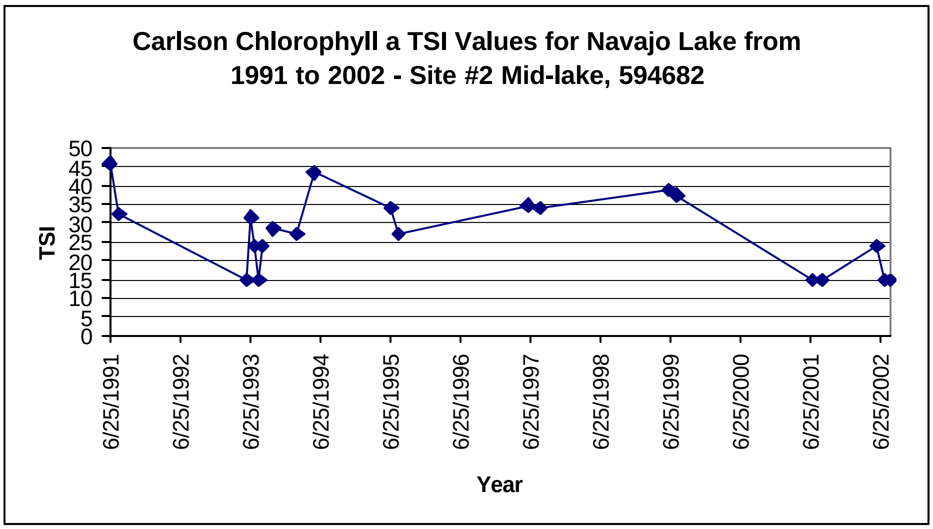
Overall, dissolved oxygen was stable for all sampling dates since the lake does not stratify but remains well mixed due to its shallow depth. Often during the summer months, the oxygen concentrations demonstrate super-saturation due to the macrophytes actively producing oxygen in the shallow lake. No data exist to confirm whether diel fluctuations occur in the water column when plants respire at night, nor are there recent winter data to demonstrate conditions of low dissolved oxygen. As mentioned previously, continual observation by DWR personnel has established that few refuges with sufficient DO exist for overwintering trout and that Navajo Lake frequently exhibits winter fish kills (Hepworth, 2003).

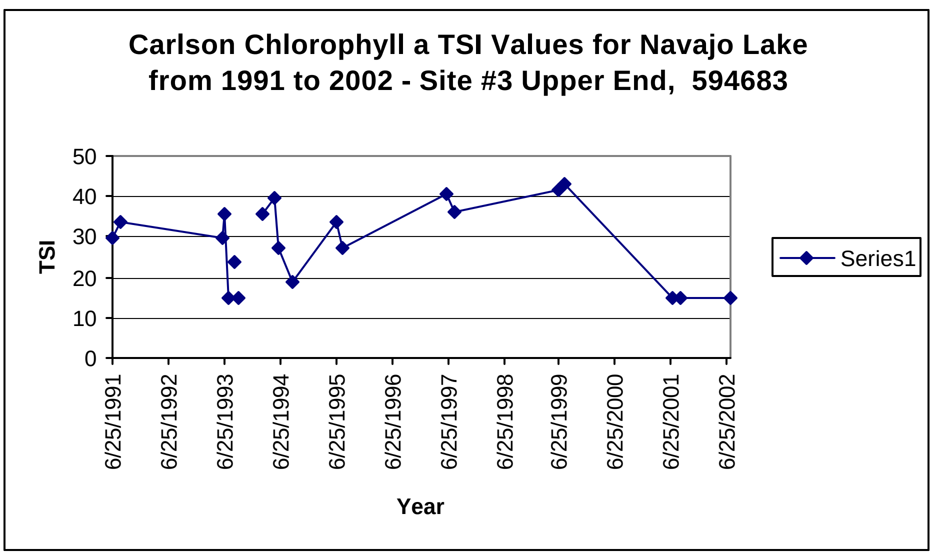
Appendix A contains the lake profiles for all 3 monitoring sites for the years 1997-2003. In short, very little fluctuation in temperature or dissolved oxygen occurs in the profiles, again due to the lake being shallow and well-mixed. No recent winter data exist to determine if winter depletion of dissolved oxygen is occurring.

The Carlson Trophic Status Index is often used to classify or predict the productivity of a lake compared to typical lakes and is determined by three indicators, chlorophyll a, secchi depth and total phosphorus concentrations. The latter two are typically used as surrogates for the most important indicator of lake productivity which is chlorophyll a. Historically, TSI values for Navajo Lake have demonstrated that it is primarily an oligotrophic lake, with very little primary production in the form of phytoplankton (measured as chlorophyll a). The Clean Lake Study determined that total phosphorus is sufficient to support higher phytoplankton growth but that long winters and a short growing season may limit their growth. Typically, the TSI values for TP indicate the lake to be somewhat mesotrophic while the chlorophyll a TSI demonstrate a predominantly oligotrophic system. Figure 1 summarizes the chlorophyll a TSIs for all available data at the three sampling locations.

Figure 1. Chlorophyll a TSI by year for three sampling locations.







In summary, the water quality of Navajo Lake is very high; its is oligotrophic to slightly mesotrophic year to year as nutrient, water depth and other conditions vary. The major management problem is the occasional depletion of oxygen under winter ice from the decomposition of abundant macrophytes. During the sampling period of the Clean Lakes Study, low DO levels were found only near the bottom under ice in February of 1994, but fair to good levels of oxygen were still available in the water column. Deeper than normal water depth and limited macrophyte growth the prior summer contributed to this condition.

VI. TMDL Water Quality Targets and Endpoints

Since the conditions in Navajo Lake and the potential for winter fish kills are independent of nutrient loads, in-lake or inflow water quality, no nutrient loading targets are recommended for this TMDL . The primary water quality target is to meet the 4.0 mg/l dissolved oxygen minimum criteria in the water column to ensure that suitable habit is provided to support the fishery during ice-free periods. Currently, Navajo Lake is meeting this criteria and is in full support of its water quality standards during this designated period. Since winter fish kills are not a function of human caused pollution but a natural occurrence due to lake morphology and macrophyte abundance, it is recommended that Navajo Lake be de-listed for dissolved oxygen. The Division of Wildlife Resources may decide to manage the lake as a year-round fishery and implement strategies to mitigate for the loss of adequate fish habitat, however, this TMDL will not recommend endpoints to that effect. Options for achieving such fishery management goals are discussed below in the implementation strategy. In order to facilitate de-listing, this study recommends the development of site-specific language in Utah's water quality standards exempting the dissolved oxygen criterion for Navajo Lake is such action is required.

VII Allocations

No allocations are recommended for this TMDL since the endpoints are not determined by measurable loads but by the attainment of the minimum concentration of 4.0 mg/l DO necessary to support the fishery. It has been determined that sources of pollutants in the watershed are minimal and are a contributing factor to impairment.

VIII. Monitoring Plan

Navajo Lake was listed as impaired for low dissolved oxygen. The data used to establish the listing is not currently available for the winter months. However, fishery managers have observed frequent fish kills as a result of low dissolved oxygen in the winter. In the future it will be useful to obtain DO profiles to assess the management strategies which may be put in place to maintain the fishery. characterize the situation and assess progress towards meeting water quality goals. Future monitoring in a process of evaluation and refinement of ensuring that water quality criteria are met during other times of the year is also recommended .

IX. Public Participation

The public participation process for this TMDL was addressed through a series of public meetings with the Upper Sevier River Watershed Committee. The Watershed Committee is comprised of individuals who represent the interest of stakeholders in the watershed. The committee has participated in this TMDL since the inception of the project, has supported the collection of relevant data and information, and has assisted with the development of management practices. In addition, the committee has developed Project Implementation Plans (PIPs) for implementation of management practices. With respect to the PIPs, the Group will select project participants and give oversight to project planning and implementation, and pursue funding mechanisms to address water quality issues in the watershed. This group actively seeks public input into the prioritization of natural resource problems and concerns. They anticipate volunteer help to be provided at many phases of the project including water conservation, irrigation improvement, tour planning, and media promotion.

A public hearing on the TMDLs was held on --------with notification of the hearing published in the local newspapers. The comment period was opened on ---------- and closed on ------------. In addition, the TMDL and dates for public comment were posted on the Division of Water Quality's website at -------------.

Coordination Plan

Lead Project Sponsor

The Upper Sevier Soil Conservation District (the District) will be the lead project sponsor. The District is empowered by the State of Utah to devise and implement measures for the prevention of nonpoint water pollution. Additionally the District is able to enter into contracts, receive and administer funds from agencies, and contract with other agencies and corporate entities to promote conservation and appropriate development of natural resources. Memoranda of Understanding with state, federal, and local agencies along with individual cooperator agreements empower the District and individual cooperators to accomplish this work.

The Upper Sevier River Watershed Committee (Local Work Group) has brought together citizens who are concerned about the future condition of the Upper Sevier River and its tributaries. They are the primary stakeholders in the future value and future problems that affect this watershed. Utah Association of Conservation Districts is a non-profit corporation that provides staffing for project coordination and financial administration to the Districts of the State of Utah, and specifically to the Upper Sevier Soil Conservation District.

The Upper Sevier River Watershed Committee or an empowered subcommittee, will provide oversight of project conceptualization, cooperator selection, volunteer efforts during implementation, and sharing of information generated by this project with others. The Upper Sevier Soil Conservation District and the Upper Sevier River Watershed Committee will oversee detailed project development, planning, implementation, approval, creation of fact sheets and educational materials, administration and reporting.

Some of these duties will be transferred to UACD, NRCS, DEQ, USU Extension Service and others as per Memoranda of Understanding. The Upper Sevier River Watershed Committee will be responsible for writing the final project report pursuant to EPA and State requirements.

UACD will oversee project administration, match documentation, and contracting with agencies and individuals. They will also provide staffing assistance at the direction of the District.

Local Support

The Upper Sevier River Watershed Committee is coordinating with local stakeholders and agencies to develop a watershed plan to further define water quality problems in the Upper Sevier River watershed and to proceed with a coordinated approach to improve water quality within the watershed. The Watershed Committee, working with a Technical Advisory Committee will establish criteria and select cooperators for implementation of projects. This project will be used to show landowners and cooperators Best Management Practices (BMPs) for minimizing land use impacts on water quality in the Upper Sevier River and its tributaries.

Coordination and Linkages

The District and Upper Sevier River Watershed Stewardship Committee anticipate coordinating efforts with the following other entities, agencies, and organizations:

Cooperators - provide match for cost share, implementation of water quality plans
Utah State University Extension - I&E, Technical assistance
NRCS - Technical planning design and oversight
Dixie National Forest- Technical, planning and financial assistance
Utah Department of Agriculture & Food - Technical assistance, I&E assistance
Utah Division of Water Quality - Standard program monitoring, Technical assistance
EPA - Financial assistance
Utah Association of Conservation Districts - Administration, contracting, staff and technical assistance
Utah Division of Water Rights- Permits advisory, and monitoring assistance
Utah Division of Water Resources - Advisory
Upper Sevier County Irrigation Companies - Advisory and TAC coordination

X Implementation Options

The following implentation options are provided as a reference to efforts in assessing and mitigating water quality impacts to Navajo Lake. The Clean Lakes Study (1996) identified several feasible implementation strategies to minimize the impacts of excessive macrophyte growth in Navajo Lake and include the following options:

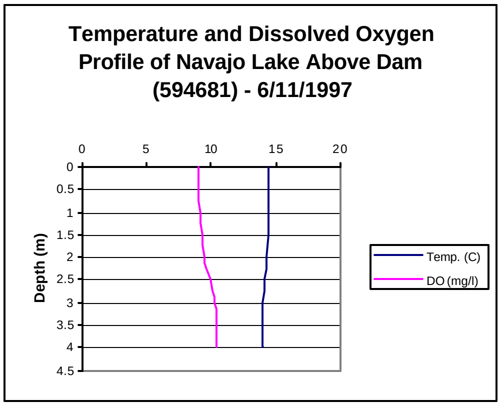
1. Mechanical removal especially during low water when the beds of macrophytes are accessible especially since water conditions favor macrophyte growth and the subsequent low dissolved oxygen in the winter months.
2. Chemical control once every few years when lake levels are low and midsummer macrophyte growth is appearing to become too profuse.
3. Grazing with herbivorous triploid grass carp, which are a sterile, long-lived, and

hardy species. Proper stocking rate would have to be observed to avoid complete grazing of macrophytes which would disrupt the lakes ecosystem and food chain. It is also possible that herbivory by carp would result in a more uniform release of nutrients via fish excreta, increasing and moderating algal productivity which in turn may increase fish productivity.

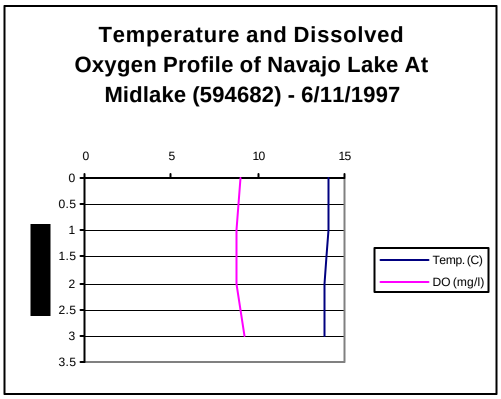
4. Aeration via mechanical aerators and pipelines from the Navajo Spring and the Forest Service culinary system. Aeration with generators has been successful in a number of lakes, but has drawbacks in the case of Navajo associated with power supplies, and access during the harsh winters. Extension of the spring outlet and the diversion of the culinary pipeline into the lake would produce a small zone of open and aerated water to sustain fish during the winter months.

The recommended plan contained in the Clean Lakes Study was a combination of the introduction of grass carp, pipelines of the Navajo Spring and the Forest Service culinary water and the chemical or mechanical removal of macrophytes in emergency years of low water and profuse plant growth. The Department of Wildlife Resources has since adopted alternative 4 and has piped spring sources into the lake to create aerated zone for fish to over winter. In addition, they have found that rotenone treatment for Utah Chub when populations increase and compete with trout for winter habitat increases the success of trout survival (Hepworth, 2003).

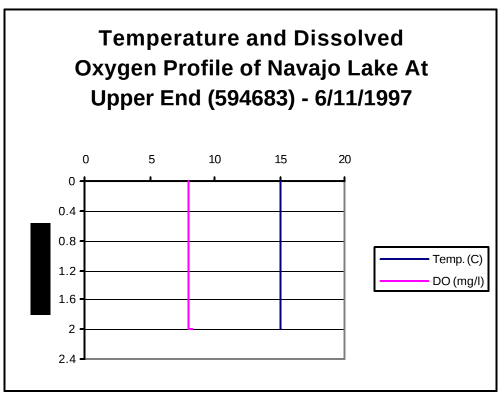
Appendix A. Lake Profiles



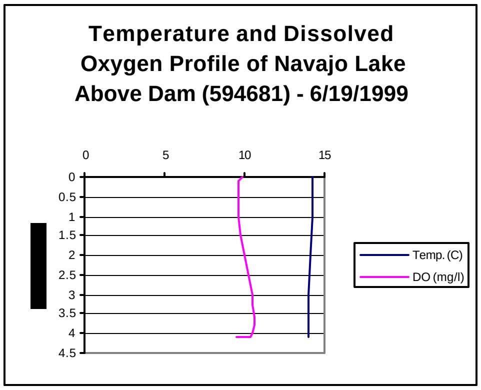
Temperature and Dissolved Oxygen Profile of Navajo Lake Above Dam (594681) - 6/11/1997



Temperature and Dissolved Oxygen Profile of Navajo Lake At Midlake (594682) - 6/11/1997



Temperature and Dissolved Oxygen Profile of Navajo Lake At Upper End (594683) - 6/11/1997


Temperature and Dissolved Oxygen Profile of Navajo Lake Above Dam (594681) - 6/19/1999
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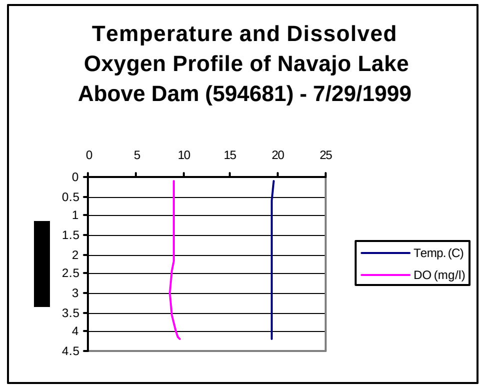
Temperature and Dissolved Oxygen Profile of Navajo Lake Above Dam (594681) - 7/29/1999
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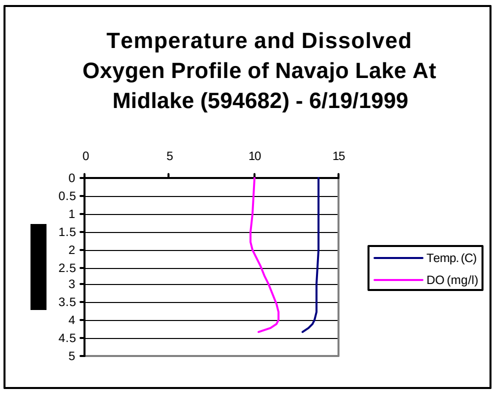
Temperature and Dissolved Oxygen Profile of Navajo Lake At Midlake (594682) - 6/19/1999
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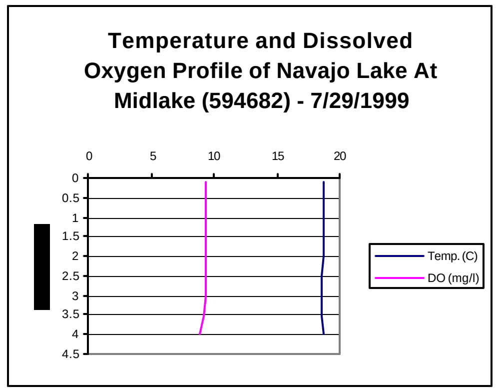
Temperature and Dissolved Oxygen Profile of Navajo Lake At Midlake (594682) - 7/29/1999
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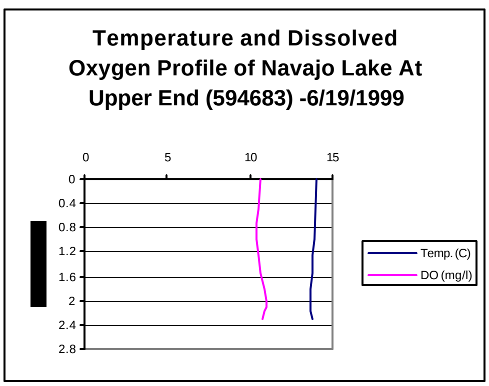
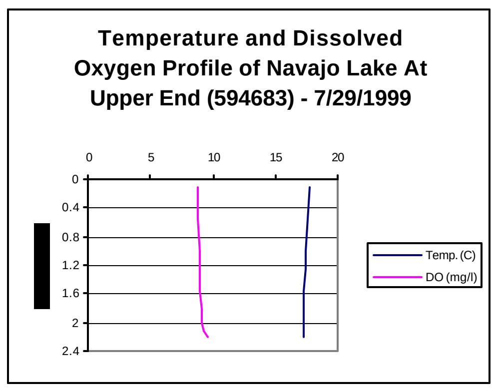
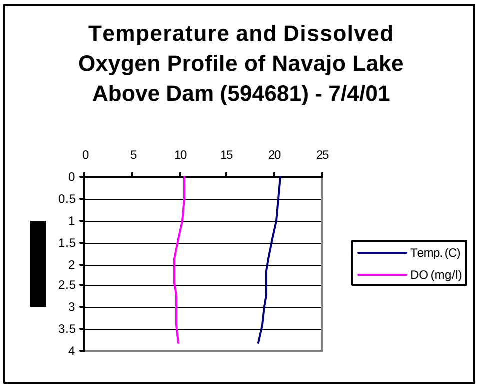
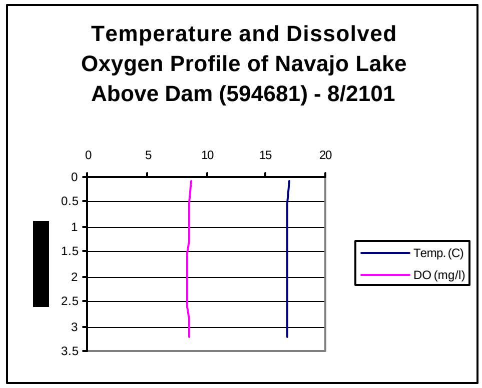
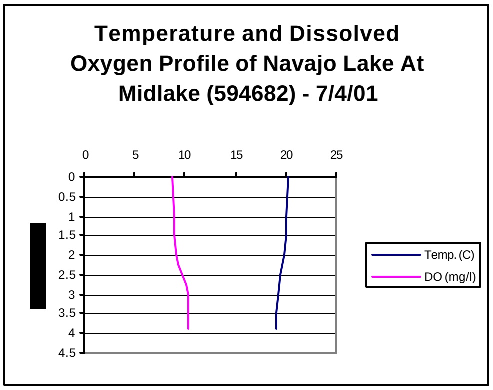
Temp. (C)
DO (mg/l)

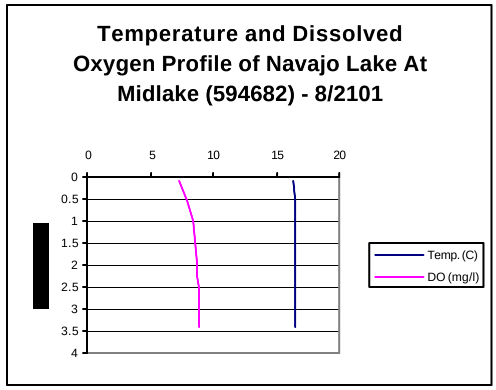

Temperature and Dissolved Oxygen Profile of Navajo Lake At Upper End (594683) -6/19/1999
0
5
10
15
0
0.4
0.8
1.2
1.6
2
2.4
2.8
[redacted]
Temp. (C)
DO (mg/l)

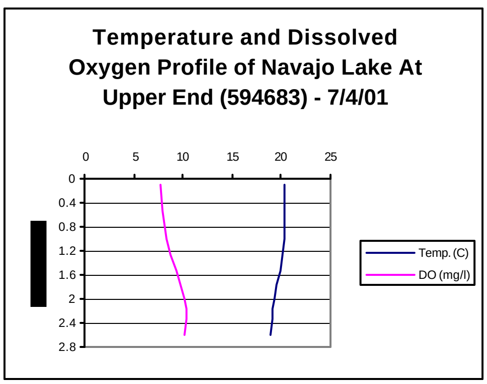

Temperature and Dissolved Oxygen Profile of Navajo Lake At Upper End (594683) - 7/29/1999
0
5
10
15
20
0
0.4
0.8
1.2
1.6
2
2.4
[redacted]
Temp. (C)
DO (mg/l)

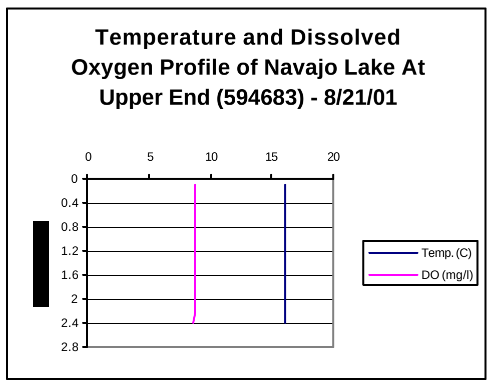

Temperature and Dissolved Oxygen Profile of Navajo Lake Above Dam (594681) - 7/4/01
[redacted]
Temp. (C)
DO (mg/l)

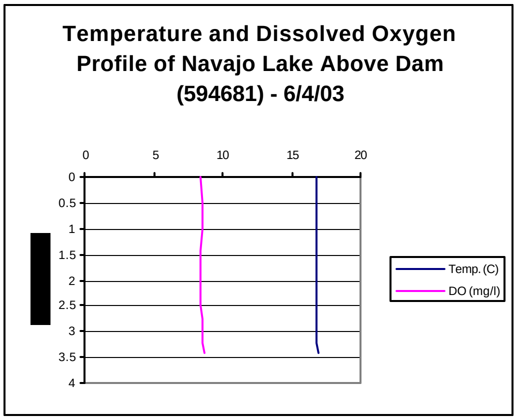

Temperature and Dissolved Oxygen Profile of Navajo Lake Above Dam (594681) - 8/2101
[redacted]
Temp. (C)
DO (mg/l)

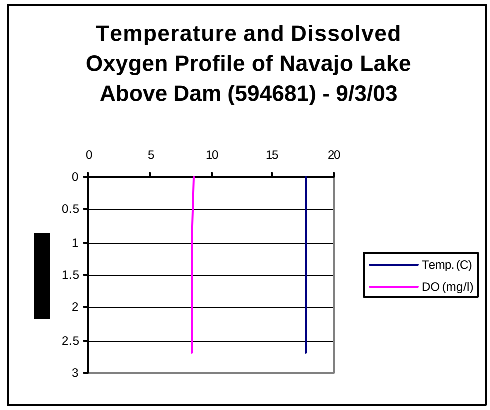

Temperature and Dissolved Oxygen Profile of Navajo Lake At Midlake (594682) - 7/4/01
[redacted]
Temp. (C)
DO (mg/l)

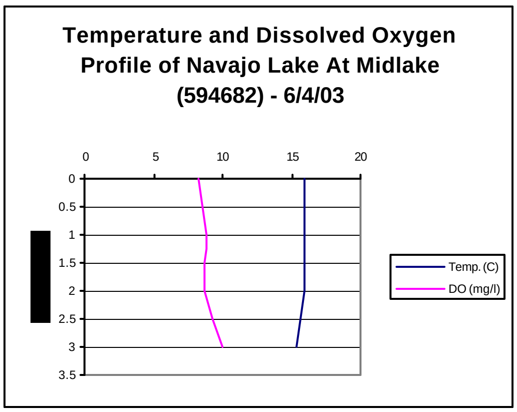

Temperature and Dissolved Oxygen Profile of Navajo Lake At Midlake (594682) - 8/2101
[redacted]
Temp. (C)
DO (mg/l)

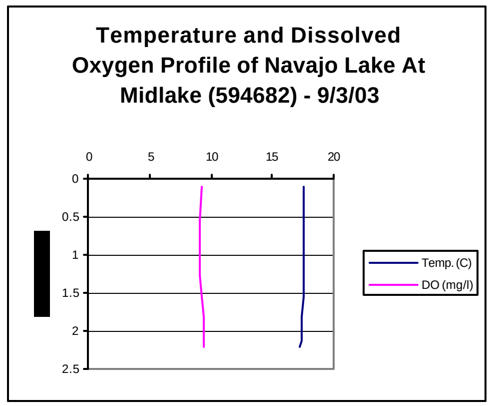

Temperature and Dissolved Oxygen Profile of Navajo Lake At Upper End (594683) - 7/4/01
[redacted]
Temp. (C)
DO (mg/l)

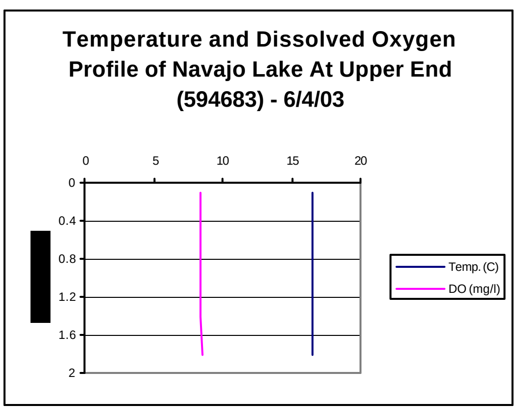

Temperature and Dissolved Oxygen Profile of Navajo Lake At Upper End (594683) - 8/21/01
[redacted]
Temp. (C)
DO (mg/l)

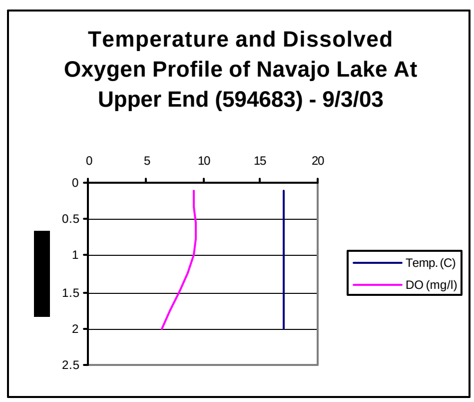

Temperature and Dissolved Oxygen Profile of Navajo Lake Above Dam (594681) - 6/4/03
0 5 10 15 20
0 0.5 1 1.5 2 2.5 3 3.5 4
[redacted]
Temp. (C)
DO (mg/l)


Temperature and Dissolved Oxygen Profile of Navajo Lake Above Dam (594681) - 9/3/03
0 5 10 15 20
0 0.5 1 1.5 2 2.5 3
[redacted]
Temp. (C)
DO (mg/l)


Temperature and Dissolved Oxygen Profile of Navajo Lake At Midlake (594682) - 6/4/03
0 5 10 15 20
0 0.5 1 1.5 2 2.5 3 3.5
[redacted]
Temp. (C)
DO (mg/l)


Temperature and Dissolved Oxygen Profile of Navajo Lake At Midlake (594682) - 9/3/03
0 5 10 15 20
0 0.5 1 1.5 2 2.5
[redacted]
Temp. (C)
DO (mg/l)


Temperature and Dissolved Oxygen Profile of Navajo Lake At Upper End (594683) - 6/4/03
0 5 10 15 20
0 0.4 0.8 1.2 1.6 2
[redacted]
Temp. (C)
DO (mg/l)


Temperature and Dissolved Oxygen Profile of Navajo Lake At Upper End (594683) - 9/3/03
0 5 10 15 20
0 0.5 1 1.5 2 2.5
[redacted]
Temp. (C)
DO (mg/l)

REFERENCES

Hepworth, Dale. 2003. Personal Communication. Utah Department of Natural Resources. Division of Wildlife Resources. Cedar City, UT. December, 2003.

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